REMARKS

Claims 1-13 are pending in the present application. Claims 14 and 15 are added with this Amendment.

Applicants and their attorney thank Examiner Nguyen for taking the time to speak with Applicants' attorney during a telephonic interview on November 4, 2002. The amendments to the Specification and the claims were discussed. No agreement was reached. Applicants and their attorney are open to further discussions or suggestions.

The Specification has been amended at pages 4 and 5 to make consistent the use of the abbreviation for "ounces per U.S. gallon". Support for this amendment is found on page 5 at lines 9 and 25.

Claims 1 and 5 have been amended to recite that a metal seed layer *having discontinuities* is contacted with the alkaline copper electroplating bath. This amendment is supported by the Specification at page 4, last 3 lines and at page 6, last 2 lines to page 7, line 2. Claims 1, 6 and 11 have been amended to specify that the substrate has one or more apparatus having a size of $\leq$ 1 μm. This is supported by the Specification at page 7, lines 25-27.

Newly added claims 14 and 15 are supported by the Specification at page 4, lines 1-5 and at page 8, lines 6-8.

No new matter is added with this Amendment.

Claims 1, 2, 4, 6, 7, 9 and 11 have been rejected under 35 USC § 102(e) as being anticipated by U.S. Patent No. 6,301,399 (Mahapatra et al.). Applicants respectfully traverse.

The Mahapatra patent fails to disclose a metal seed layer having discontinuities. Further, this patent fails to disclose a substrate having one or more apertures (such as vias or trenches) having a size of $\leq$ 1 μm. Applicants submit that their invention is <u>not</u> anticipated by the Mahapatra patent and respectfully request that this rejection be withdrawn.

Claims 3 and 8 have been rejected under 35 USC § 103(a) as being unpatentable over Mahapatra et al. in view of Zhu et al. (U.S. 6,402,592). Applicants respectfully submit that this rejection is improper. The Zhu et al. patent has a filing date of January 17, 2001. The present Application claims the benefit of priority of U.S. Provisional Application No. 60/242,349, filed on October 20, 2000. Thus, Zhu's filing date is after Applicants' priority date and Applicants submit that the Examiner's reliance on the Zhu et al. patent is improper.

Claims 5 and 10 have been rejected under 35 USC § 103(a) as being unpatentable over Mahapatra in view of Kaneko et al. (U.S. 6,416,571). Applicants respectfully traverse.

The Mahapatra patent fails to disclose discontinuous metal seed layers and, in fact, fails to recognize the problems associated with discontinuous metal seed layers. Such discontinuous metal seed layers are particularly problematic on substrates having one or more apertures having a size of ≤ 1 μm. Mahapatra neither discloses nor suggests substrates having apertures having a size of ≤ 1 μm and in fact fails to disclose or suggest substrates having any apertures at all.

The Exmainer relies on the Kaneko patent for the use of a brightener in tin-copper plating baths. However, this patent fails to fill the deficiencies of Mahapatra. This patent does not disclose or suggest discontinuous seed layers or the need to repair discontinuous metal seed layers. In addition, this patent neither discloses nor suggests substrates having apertures having a size of ≤ 1 μm.

The Mahapatra patent is concerned with optic modulators and uses low resistivity metals of copper or silver (see column 4, lines 45-47). This patent fails to recognize the use of brighteners in a copper-pyrophosphate plating bath. There is nothing in this patent that would lead one skilled in the art to look to a tin-copper alloy plating bath for additional plating bath components, such as brighteners. Even if one were to combine these references, there is nothing in this combination that teaches or suggests Applicants' method of repairing or enhancing a discontinuous metal seed layer on a substrate having one or more apertures having a size of ≤

1μm. Accordingly, Applicants submit that the Examiner has not made out a prima facie case of obviousness and respectfully requests that this rejection be withdrawn.

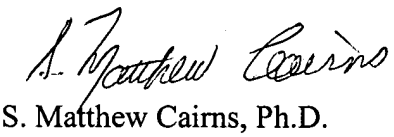
Claims 12 and 13 have been rejected under 35 USC § 103(a) as being unpatentable over Cohen (U.S. Patent No. 6,136,707) in view of Mahapatra.

Cohen discloses a method of making metallic interconnects by first depositing a conformal seed layer, followed by depositing a non-conformal seed layer to provide a continuous "two-step" seed layer, which is subsequently electroplated with copper. Cohen expressly states at column 6, lines 4-8 that such "two-step" seed layer is required to provide a continuous seed layer for subsequent electroplating. Thus, in contrast to the Examiner's assertion, the seed layer of Cohen is not inherently enhanced by the overlying electrodeposited layer. Rather, the seed layer is "enhanced" by the deposition of a second seed layer. The Cohen patent only discloses vapor deposition techniques as means for providing a continuous seed layer. See column 5, lines 18-29. This patent fails to teach or suggest alkaline copper electroplating baths containing pyrophosphate.

Mahapatra is discussed above. There is nothing in either Cohen or Mahaptra that would lead one to combine these references. Even if one did combine them, one would at best first deposit a conformal seed layer and then deposit a non-conformal seed layer by vapor deposition techniques according to Cohen to provide a continuous seed layer and then electroplate copper on the continuous seed layer using the plating bath of Mahapatra. An advantage of Applicants' invention is that such second seed layer vapor deposition step can be eliminated, i.e. a discontinuous seed layer can be repaired by using an alkaline copper electroplating bath containing pyrophosphate. Such a result cannot be predicted from a combination of these references. Applicants submit that the Examiner has not made out a prima facie case of obviousness and respectfully request that this rejection be withdrawn.

Based on the foregoing, favorable reconsideration in the form of a notice of allowance is respectfully requested.

Respectfully submitted,



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ATTACHMENT A

As used throughout the specification, the following abbreviations shall have the following meanings, unless the context clearly indicates otherwise: nm = nanometers; g/L = grams per liter; oz/gal = ounces per U.S. gallon; μm = micron = micrometer; ASF = amperes per square foot; M = molar; mA/cm^2 = milliamperes per square centimeter; ° C = degrees Centigrade; ° F = degrees Fahrenheit; and ppm = parts per million.

ATTACHMENT B
VERSION SHOWING CHANGES MADE

As used throughout the specification, the following abbreviations shall have the following meanings, unless the context clearly indicates otherwise: nm = nanometers; g/L = grams per liter; ~~oz~~/goz/gal = ounces per U.S. gallon; μm = micron = micrometer; ASF = amperes per square foot; M = molar; mA/cm^2 = milliamperes per square centimeter; ° C = degrees Centigrade; ° F = degrees Fahrenheit; and ppm = parts per million.

ATTACHMENT C

Copper pyrophosphate is present in the electroplating baths in an amount of from about 2.5 oz/gal to about 4 oz/gal. Amounts above and below this range may be used but with less desirable copper deposits.

The seed layer repairing electroplating baths may also contain amounts of other alloying elements. Thus, the copper electroplating baths useful in the present invention may deposit copper or copper alloy.

The pH of the present alkaline electroplating baths is typically in the range of from >7 to 11, preferably 7.5 to 9, more preferably 8 to 9, still more preferably 8 to 8.8, and even more preferably 8.1 to 8.5. It is preferred that the pH is $\leq$9 as baths having a pH >9 tend to cause roughness and a decrease in current density. Baths having a pH <7 tend to cause orthophosphate buildup and a loss of throwing power. Suitable complexing agents include pyrophosphate salts such as potassium pyrophosphate and sodium pyrophosphate. Typically, the pyrophosphate to copper ratio is in the range of from 5:1 to 9.5:1, preferably 6:1 to 9.5:1, more preferably 7:1 to 9:1 and even more preferably 7.5:1 to 8:1.

One or more bases may optionally be added to the present electroplating baths. Suitable optional bases include, but are not limited to, ammonium hydroxide and tetra(C_1-C_4)alkylammonium hydroxides such as tetramethylammonium hydroxide. The amount of bases may be from 0.05 to 0.5 oz/gal, and preferably from 0.1 to 0.4 oz/gal.

ATTACHMENT D
VERSION SHOWING CHANGES MADE

Copper pyrophosphate is present in the electroplating baths in an amount of from about 2.5 ~~oz/~~goz/gal to about 4 oz/gal. Amounts above and below this range may be used but with less desirable copper deposits.

The seed layer repairing electroplating baths may also contain amounts of other alloying elements. Thus, the copper electroplating baths useful in the present invention may deposit copper or copper alloy.

The pH of the present alkaline electroplating baths is typically in the range of from >7 to 11, preferably 7.5 to 9, more preferably 8 to 9, still more preferably 8 to 8.8, and even more preferably 8.1 to 8.5. It is preferred that the pH is $\leq$9 as baths having a pH >9 tend to cause roughness and a decrease in current density. Baths having a pH <7 tend to cause orthophosphate buildup and a loss of throwing power. Suitable complexing agents include pyrophosphate salts such as potassium pyrophosphate and sodium pyrophosphate. Typically, the pyrophosphate to copper ratio is in the range of from 5:1 to 9.5:1, preferably 6:1 to 9.5:1, more preferably 7:1 to 9:1 and even more preferably 7.5:1 to 8:1.

One or more bases may optionally be added to the present electroplating baths. Suitable optional bases include, but are not limited to, ammonium hydroxide and tetra(C_1-C_4)alkylammonium hydroxides such as tetramethylammonium hydroxide. The amount of bases may be from 0.05 to 0.5 oz/gal, and preferably from 0.1 to 0.4 ~~oz/~~goz/gal.

ATTACHMENT E

Sub C1 B3

1. (Amended) A method of providing a metal seed layer substantially free of discontinuities disposed on a substrate comprising the step of contacting a metal seed layer having discontinuities disposed on a substrate having one or more apertures having a size of ≤ 1 μm with an alkaline copper electroplating bath comprising copper pyrophosphate.

B4

6. (Amended) A method of manufacturing an electronic device comprising the step of contacting a metal seed layer having discontinuities disposed on a substrate having one or more apertures having a size of ≤ 1 μm with an alkaline copper electroplating bath comprising copper pyrophosphate. C

B5

11. (Amended) An article of manufacture comprising an electronic device substrate containing one or more apertures having a size of ≤ 1 μm, each aperture containing a seed layer deposit enhanced by contact with an alkaline electroplating composition that comprises copper pyrophosphate.

ATTACHMENT F
VERSION SHOWING CHANGES MADE

1. (Amended) A method of providing a metal seed layer substantially free of discontinuities disposed on a substrate comprising the step of contacting a metal seed layer having discontinuities disposed on a substrate having one or more apertures having a size of ≤ 1μm with an alkaline copper electroplating bath comprising copper pyrophosphate.

6. (Amended) A method of manufacturing an electronic device comprising the step of contacting a metal seed layer having discontinuities disposed on a substrate having one or more apertures having a size of ≤ 1μm with an alkaline copper electroplating bath comprising copper pyrophosphate.

11. (Amended) An article of manufacture comprising an electronic device substrate containing one or more apertures having a size of ≤ 1μm, each aperture containing a seed layer deposit enhanced by contact with an alkaline electroplating composition that comprises copper pyrophosphate.

ATTACHMENT G
NEWLY ADDED CLAIMS

Sub C1 7

14. (New) The method of claim 1 further comprising the step of subjecting the electroplating bath to sufficient current density to provide a metal seed layer substantially free of discontinuities.

B6

15. (New) The method of claim 6 further comprising the step of subjecting the electroplating bath to sufficient current density to provide a metal seed layer substantially free of discontinuities.